Hybrid Model of Solar – Wind Power System

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Abstract: **Renewable energy sources i.e. energy generated from solar, wind, biomass, hydro power, geothermal and ocean resources are considered as a technological option for generating clean energy. But the energy generated from solar and wind is much less than the production by fossil fuels, however, electricity generation by utilizing PV cells and wind turbine increased rapidly in recent years. This paper presents the Solar-Wind hybrid Power system that harnesses the renewable energies in Sun and Wind to generate electricity. System control relies mainly on micro controller. It ensures the optimum utilization of resources and hence improves the efficiency as compared with their individual mode of generation. Also it increases the reliability and reduces the dependence on one single source. This hybrid solar-wind power generating system is suitable for industries and also domestic areas energy sources**

Keywords: Solar energy, Wind energy, Renewable energy, PV cell, Hybrid power system

I. INTRODUCTION

We all know that the world is facing a major threat of fast depletion of the fossil fuel reserves. Most of the present energy demand is met by fossil and nuclear power plants. A small part is met by renewable energy technologies such as the wind, solar, biomass, geothermal etc. There will soon be a time when we will face a severe fuel shortage. As per the law of conservation of energy, "Energy can neither be created, nor be destroyed, but it can only be converted from one form to another". Most of the research now is about how to conserve the energy and how to utilize the energy in a better way. Research has also been into the development of reliable and robust systems to harness energy from nonconventional energy resources. Among them, the wind and solar power sources have experienced a remarkably rapid growth in the past 10 years. Both are pollution free sources of abundant power. Solar energy is energy from the Sun. It is renewable, inexhaustible and environmental pollution free. Solar charged battery systems provide power supply for complete 24 hours a day irrespective of bad weather. By adopting the appropriate technology for the concerned geographical location, we can extract a large amount of power from solar radiations. More over solar energy is expected to be the most promising alternate source of energy. The global search and the rise in the cost of conventional fossil fuel is making supply-demand of electricity product almost impossible especially in some remote areas. Generators which are often used as an alternative to conventional power supply systems are known to be run only during certain hours of the day, and the cost of fuelling them is increasingly becoming difficult if they are to be used for commercial purposes. Wind energy is the kinetic energy associated with the movement of atmospheric air. It has been used for hundreds of years for sailing, grinding grain and for irrigation. Wind energy systems convert this kinetic energy to more useful forms of power. Wind energy systems for irrigation and milling have been in use since ancient times and at the beginning of the 20th century it is being used to generate electric power. Windmills for water pumping have been installed in many countries particularly in the rural areas. Wind turbines transform the energy in the wind into mechanical power, which can then be used directly for grinding etc. or further converting to electric power to generate electricity. Wind turbines can be used singly or in clusters called 'wind farms.

There is a growing awareness that renewable energy such as photovoltaic system and Wind power have an important role to play in order to save the situation. Hybrid power system consist of a combination of renewable energy source such as wind generators, solar etc of charge batteries and provide power to meet the energy demand, considering the local geography and other details of the place of installation. These types of systems are not connected to the main utility grid. They are also used in stand-alone applications and operate independently and reliably. The best application for these types of systems are in remote places, such as rural villages, in telecommunications etc. The importance of hybrid systems has grown as they appear to be the right solution for a clean and distributed energy production [1]. This paper presents the Solar-Wind hybrid Power system that harnesses the renewable energies in Sun and Wind to generate and supply electricity to a private house, farm house, a small company, an educational institution or an apartment house depending on the need at the site where used.

A. Wind Energy Conversion System

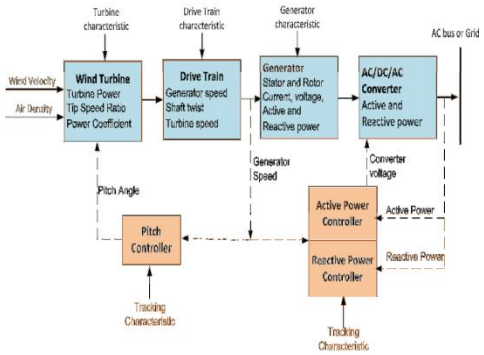

Fig. 1. Wind Energy Conversion System

The wind energy conversion system (WECS) consists of a turbine to capture the kinetic energy in the wind, a drive train to speed up the rotational speed of the shaft, than, a generator to convert the mechanical energy into electrical energy (see Fig. 1). In this paper, a variable-speed wind turbine with the capability of continuous adjustment (i.e. acceleration or deceleration) of the rotational speed " ω" of the wind turbine to the wind speed "***ν***" is used. The most important classification of variable-speed wind turbines is according to generator used, among them, WECS equipped with doubly fed inductance generators (DFIGs) are the most common type used. Opportunity of pitch control with an efficient transmission of the power to the grid through active and reactive power control has made because they are very attractive due to the increasing issue of the wind power impact on the electrical network. In these above types of generators, the stator (Stationery) of the generators is directly connected to the grid and the rotor power is handled by converters. In this model consists of three main parts: wind turbine rotor, drive train, and generator. The wind turbine rotor converts the kinetic energy of the wind into mechanical energy by producing torque. Since the energy contained in the wind is in the form of kinetic energy, its magnitude depends on the

B. Solar Energy Conversion System

When the sun light hits the semiconductor surface of a solar cell, electron springs up and attracted towards the N type semiconductor material. This will cause more negatives in the N-type and more positives in the P-type semiconductors generating a higher flow of electricity. This is known as the Photovoltaic effect. The amount of current generated by a PV cell depends on its efficiency (type of PV cell) its size (surface area) and the intensity of sunlight striking the surface. A single solar cell can only create a little amount of power and hence to get a larger effect solar cells are either connected in series or parallel. Solar array or PV module is made up of many solar cells connected either in series or parallel Cross section of a PV cell is shown in Fig

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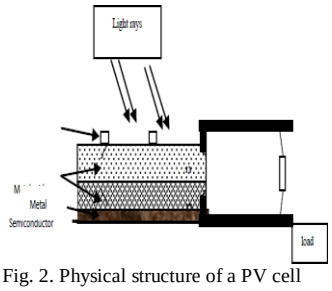

Fig. 2. Physical structure of a PV cell

The solar energy conversion system or the physical of PV cell is very similar to that of the classical diode with a PN junction formed by semiconductor material. When the junction absorbs light, the energy of absorbed photon is transferred to the electron-proton system of the material, creating charge carriers that are separated at the junction. The charge carriers in the junction region create a potential gradient, get accelerated under the electric field, and circulate as current through an external circuit. The solar cell is the basic building of the PV power which solar energy is converted directly into electrical energy.

II. SOLAR-WIND HYBRID ENERGY SYSTEM

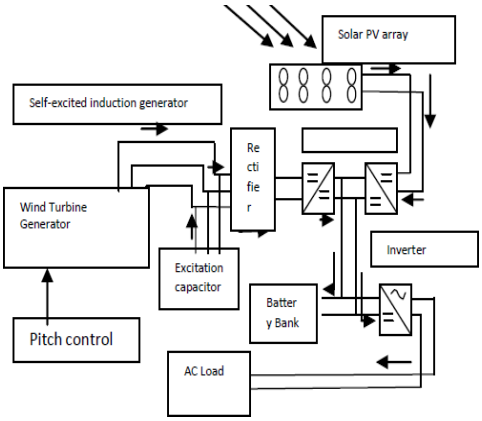

Fig. 3. Functional block diagram of hybrid wind solar energy system.

Solar-Wind hybrid Power system is the combined power generating system by wind mill and solar energy panel. It also includes a battery which is used to store the energy generated from both the sources. Using this system power generation by windmill when wind source is available and generation from PV module when light radiation is available can be achieved. Both units can be generated power when both sources are available. By providing the battery uninterrupted power supply is possible when both sources are idle.

Fig.3. shows the functional block diagram of hybrid wind solar energy system. The power generated from wind mill is of AC voltage which is converted through AC-DC rectifier. A special type of converter is used to step up or step down through MOSFET switching called "SEPIC" converter for wind mill. For solar system

converter is used for the regulation. The micro controller incorporated in this scheme, which regularly refers the operation of sources and switches the corresponding converters and fed into change the battery or to the load through inverters. The output of the inverter is connected with the load and after that the voltage is stepped up by a transformer. The driver circuit is used to give the gate signal for the MOSFET of converters.

III. IMPLEMENTATIO OF HYBRID ENERGY SYSTEM

Intermittent energy resources and energy resources unbalance are the most important reason to install a hybrid energy supply system. The Solar PV wind hybrid system suits to conditions where sunlight and wind has seasonal shifts [2]. As the wind does not blow throughout the day and the sun does not shine for the entire day, using a single source will not be a suitable choice. A hybrid arrangement of combining the power harnessed from both the wind and the sun and stored in a battery can be a much more reliable and realistic power source. The load can still be powered using the stored energy in the batteries even when there is no sun or wind. Hybrid systems are usually built for design of systems with lowest possible cost and also with maximum reliability. The high cost of solar PV cells makes it less competent for larger capacity designs. This is where the wind turbine comes into the picture, the main feature being its cheap cost as compared to the PV cells. Battery system is needed to store solar and wind energy produced during the day time. During night time, the presence of wind is an added advantage, which increases the reliability of the system. In the monsoon seasons, the effect of sun is less at the site and thus it is apt to use a hybrid wind solar system. The system components are as follows.

1. PHOTOVOLTAIC SOLAR CELLS:

Solar panels are the medium to convert solar energy into the electrical energy. Solar panels can convert the energy directly or heat the water with the induced energy. PV (Photo-voltaic) cells are made up from semiconductor structures as in the computer technologies. Sun rays are absorbed with this material and electrons are emitted from the atoms .This release activates a current. Photovoltaic is known as the process between radiation absorbed and the electricity induced. Solar power is converted into the electric power by a common principle called photo electric effect. The solar cell array or panel consists of an appropriate number of solar cell modules connected in series or parallel based on the required current and voltage.

2. WIND POWER

The wind energy is a renewable source of energy. Wind turbines are used to convert the wind power into electric power. Electric generator inside the turbine converts the mechanical power into the electric power. Wind turbine systems are available ranging from 50W to 3-4 MW. The energy production by wind turbines depends on the wind velocity acting on the turbine. Wind power is able to feed both energy production and demand in the rural areas. It is used to run a windmill which in turn drives a wind generator or wind turbine to produce electricity [3].

3. BATTERIES

The batteries in the system provide to store the electricity that is generated from the wind or the solar power. Any required capacity can be obtained by serial or parallel connections of the batteries. The battery that provides the most advantageous operation in the solar and wind power systems are maintenance free dry type and utilizes the special electrolytes. These batteries provide a perfect performance for long discharges [4].

4. INVERTER

Energy stored in the battery is drawn by electrical loads through the inverter, which converts DC power into AC power. The inverter has in-built protection for Short-Circuit, Reverse Polarity, Low Battery Voltage and Over Load.

5. MICROCONTROLLER

The microcontroller compares the input of both Power system and gives the signal to the particular relay and charges the DC Battery. The DC voltage is converted into AC Supply by Inverter Circuit. The MOSFET (IRF 540) is connected to the Secondary of the centre tapped transformer. By triggering of MOSFET alternatively, the current flow in the Primary winding is also alternative in nature and we get the AC supply in the primary winding of the transformer. Depending on the environmental conditions, required energy for the system can be supplied either separately from the wind or solar systems or using these two resources at the same time is shown in Fig. 2.

V. CONCLUSION

In the present work a Solar PV Wind Hybrid Energy System was implemented. A portion of the energy requirement for a private house, farm house, a small company, an educational institution or an apartment house depending on the need at the site where used has been supplied with the electricity generated from the wind and solar power. It reduces the dependence on one single source and has increased the reliability. Hence we could improve the efficiency of the system as compared with their individual mode of generation.

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